NAVAIR
Non Contact In-Process Inspection

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Overview

- Background on Navy 3D Model Status
  - (3MS / MBD)
- Proposed System Examples
- Definition of Digital Product Definition and Model-Based Definition (MBD)
- Model-Based GD&T for Inspection
- Challenges
- Resources
F/A-18 IWP CLOSURE RIB

74A110781
IWP Closure Rib

Detail AA
CLOSURE RIB COMPARAISON

Part from 2D Blue Print

Scanned Part from Aircraft

Part Superimposed

Areas of Interest
CLOSURE RIB ADVANCED MEASUREMENT

Bell Curve 6σ

Model Deviation Graph

FaroArm®

Verisurf Build
CLOSURE RIB ML DEFINITION PER B/P

Part Drafted per B/P

Modified the B/P To Reflect the Part
NLG ACTUATOR SUPPORTS

- 74A314653-2011/-2019/-2027
- 74A314654-2027
- 74R310035-2005
- 74A314626-2003/-2005A

FWD

NLG Actuator
Comparing Manufacturing & Engineering 3D CAD Models

74R310035-2005 Manufacturing Model
74R310035-2005 Engineering Model
74A310035-2005 Superimposed

Critical Spot 1: Smaller Thickness
Δ=0.040”

Critical Spot 2: Smaller Radius
Differences between Manufacturing & Engineering
Critical Spot #1 74R310035-2005

Manufacturing Model

Engineering Model

Manufacturing Model

Engineering Model
Manufactured Parts Do Not Conform to B/P

74A314626-2003/74A314626-2005A

Manufactured Part

Engineering CAD Model

MISSING STEP ON BOTH SIDES

Step

STEP ON BOTH SIDES
Comparing Manufacturing & Engineering 3D Models

Critical Spot 1

74A314653-2011 Manufacturing Model

74A314653-2011A

74A314653-2011 Engineering Model

Critical Spot 2

74A314653-2011 Superimposed
Traditional CMM’s Approach

![Image of CMM machine]

**First Article Inspection Report**

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Capital Improvement Project (CIP)

• Approx $36M total investment across three fleet readiness centers
  • FRC-SW - San Diego, CA
  • FRC-SE – Jacksonville, FL
  • FRC-E – New Bern, NC

• In Process Inspection System
  • $800K Y16 / Y17 Project
Measuring Large Structure
Manufacturing Parts
ATOS Scanbox
Model-Based Inspection Solutions
QA Reporting to MBD
WHAT IS A MBD?

Model Based Definition, MBD is Using the Native CAD Model as the Sole Data Authority
MODEL BASED DEFINITION
MDB

Print: 2D

PRESENT & FUTURE: 3D MBD
3D SOLID MODEL BASE DEFINITION

- Dimensions
- Tolerances
- Flag Notes
- Datums
- Annotations
• The Model Based Enterprise (MBE) is made up of many related processes. At its core is the product definition which we refer to as the Model Based Definition (MBD). Another way to define MBD is an annotated 3D CAD Model that contains all the information needed to define a product. This annotated model replaces a traditional drawing. Thus, a drawing is created by exception not as a standard process.
MBD at the center of Product Lifecycle Management
Value of MBD

• With authority bestowed on the model, MBD will:
  • Eliminate errors that result from referencing an incorrect source.
  • Make processes more efficient—no more searching to determine correct revision levels.
  • Eliminate outdated drawings floating around the manufacturing floor.
  • Eliminate discrepancy between the CAD model and 2D documentation.
Where MBD Is Best Applied

• Complex surface profiles
• Complex products with large bills of materials
• Mission critical components with high liability
• Long product lives
• Global supply chains
• Stringent regulatory requirements
Product Structure in a MBD Environment

- **Product Definitions**
  - Digital Product Definition (DPD - 3D authority)
  - Product Definition (2D authority)
    - Model Based Definition (MBD)
    - 3D Master (drawing allowed)
      - Product Manufacturing Information (PMI)
        - Geometric Dimensioning & Tolerancing (3D GD&T)
        - Geometric Dimensioning & Tolerancing (2D GD&T)
          - Representation (semantic)
          - Presentation (display)
            - Model-Based GD&T
              - Tolerance Analysis
              - Simulation
              - Manufacture
              - Inspection
Model-Based GD&T Annotations
Model-Based Enterprise Broken

Model Based Definition
- 3D Solid Models
- CAD Intelligence Utilized
- Automated Digital Processes

Model Based Definition Broken
- Productivity Barrier
- Quality Data Loop Broken
- Statistical Improvement Impeded

Drawing Based Definition
- 2D Drawings
- CAD Intelligence Lost
- Manual Analog Hand Tools

Design
3D Modeling

Engineering
3D Simulation

Manufacturing
3D Tool Paths

Inspection
2D Drawings
Model-Based Enterprise Applied

Model Based Definition
- 3D Solid Models
- CAD Intelligence Utilized
- Automated Digital Processes

Model Based Definition Extended
- Productivity Improved
- No 2D Drawing Waste
- 3D Quality Data Loop Closed

Model Based Inspection
- 3D Profile with Tolerances
- CAD Intelligence Utilized
- Automated Digital Process

Design
3D Modeling

Engineering
3D Simulation

Manufacturing
3D Tool Paths

Inspection
3D Measurements

3D Quality Improvement
Benefits of Model-Based Measurement and Inspection

- No 2D Drawings
  - Cost and time eliminated
  - Contradictions removed
- Automated inspection planning
- Automated report formatting
- Accuracy
  - All features included in plan
  - No interpretation errors
  - GD&T rule checking
  - No data entry errors
- Prompted inspection procedures
- Live, graphical measurement display
- Automated reporting
  - No data entry
  - No manual calculations
- Only basic skills needed
- Eliminate CMM overhead (PCMM)
  - No fixtures
  - No part set-up
  - No programming
  - No manual data recording
Model-Based Large Volume Measurement Applications

Tooling Fabrication and Validation

Automated high precision inspection and R&R studies

Large volume Inspection

Real time Model-Based Inspections
Model-Based Inspection Solutions
Import 3D CAD & MBD

- CATIA – Dassault
- UG - Siemens
- Pro/ENGINEER - PTC
- SolidWorks - Dassault
- Inventor - Autodesk
- SolidEdge - Siemens
Model-Based Inspection Solutions
Connect To Metrology Devices
Model-Based Inspection Solutions
Create MBD
Model-Based Inspection Solutions
Automated Inspection Plans to MBD
Model-Based Inspection Solutions
Analyze & Display Inspection Data
MBD Implementation Levels

Level 0
- Drawing Centric
- Disconnected Manufacturing - Disconnected Enterprise
- Primary Deliverable: 2D Drawing

Level 1
- Model Centric
- Neutral Model CAM - Disconnected Enterprise
- Primary Deliverable: 2D Drawing and Neutral CAD Model

Level 2
- Model Centric
- Native Model CAM - Disconnected Enterprise
- Primary Deliverable: 2D drawing and Native CAD Model

Level 3
- Model Based Definition
- Native Model CAM - Disconnected Enterprise
- Primary Deliverable: 3D Annotated Model and Light Weight viewable

Level 4
- Model Based Definition
- Integrated Manufacturing - Disconnected Enterprise
- Primary Deliverable: 3D Annotated Model and Light Weight viewable via PLM

Level 5
- Model Based Enterprise
- Integrated Manufacturing - Integrated Internal Enterprise
- Primary Deliverable: Digital Product Definition Package and TDP

Level 6
- Model Based Enterprise
- Integrated Manufacturing - Integrated Extended Enterprise
- Primary Deliverable: Digital Product Definition Package and TDP via the web

Courtesy of Model Based Enterprise
Challenges

Interoperability

- CATIA – Dassault
- UG - Siemens
- Pro/ENGINEER - PTC
- SolidWorks - Dassault
- Inventor - Autodesk
- SolidEdge - Siemens
Challenges

Eliminating Drawings
Challenges

**Legacy Data**

- Time between CAD Versions: 6 months
- Life of Operating System: 18 months
- Life of Computer: 3 years
- Life of CAD System: 10 years
- Life of Product: 70 years +

**time**
Challenges

**CAD Translation & Validation**

When Boeing DPD data containing 3D geometry is received in translated format (e.g., IGES, STEP), the supplier must verify their translation of each dataset or have a process to verify and validate translation software (per Section 3.), in order to maintain authority status.
9.2 Translations - Suppliers are responsible for all dataset translations used for manufacturing and inspection, and must have a clear documented process for each. The documented process must include a method to verify the accuracy of translations. (See definitions for description of “translation”.)

9.2.1. Acceptance criteria for accuracy of translated surface profile/geometry, (tolerance) must be determined by the supplier, and must ensure the end product will be within engineering tolerance/specification. Objective evidence of translation validation must be retained. (Typical allowable deviation tolerance is .0001 to .001 inch)

9.2.2. Suppliers must be able to demonstrate the CAD translation process, including verification/interrogation methods used, and the ability to identify known discrepancies.

9.2.3. The verification process for translation of datasets containing 3D annotation, i.e. feature control frames, dimensions, text, and/or surface geometry must ensure that all intended entities are accounted for in the translated dataset.
Challenges

Changing Process

- Design 3D Modeling
- Engineering 3D Simulation
- Manufacturing 3D Tool Paths
- Inspection 2D Drawings
Challenges

Changing People
Predictions
Predictions

- 3D Global Supply Chains
- Elimination of 2D Drawings
- STEP AP242 Will Enhance Interoperability
- Increased Noncontact Inspection & 3D Scanning
- Cloud Based Inspection Databases
- SPC of Key Characteristics
- 3D Maintenance Repair Overhaul
Additional Information

- **STEP AP242** - Managed Model Based 3D Engineering
- **ISO 10303** - STEP Standard for the Exchange of Product model data
- **Quality Information Framework (QIF)**
- **Aerospace Industries Association (AIA) Engineering Data Interoperability Group (EDIG)**
- **Automotive Industry Action Group (AIAG)**
- **Model Based Enterprise**
Thank You!
Reverse Engineering, 3D Scanning & Tolerancing

Review & Wrap-Up

25 August 2015
Next JTEG Technology Forum

Cold Spray Repair

29 September 2015